

Collection of Simulated XRD Powder Patterns for Zeolites

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Collection of Simulated XRD Powder Patterns for Zeolites

M.M.J. Treacy and J.B. Higgins

Published on behalf of the Stucture Commision of the International Zeolite Association Fourth Revised Edition



Amsterdam - London - New York - Oxford - Paris - Shannon - Tokyo

ELSEVIER SCIENCE B.V. Sara Burgerhartstraat 25 P.O. Box 211, 1000 AE Amsterdam, The Netherlands

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Fourth revised edition, first impression 2001. Fourth revised edition, second impression 2001.

Library of Congress Cataloging in Publication Data A catalog record from the Library of Congress has been applied for.

ISBN: 0-444-50702-7

⊕ The paper used in this publication meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).

Transferred to digital printing 2006.

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PREFACE

The synthesis and characterization of new zeolite materials continues unabated. The IZA Structure Commission has recognized thirty-five new topologies since the 3rd edition of this *Collection* was prepared in 1995. The total number of zeolite structure refinements has surpassed 3000 with over 1000 new refinements since 1995. Not surprisingly, the most scrutinized framework topology is that of faujasite, **FAU**, with about 600 structural studies. Probably no other inorganic host structure has received such attention. With these numbers it is apparent that this *Collection* is not comprehensive. The scope of the *Collection* has been broadly defined to include materials of interest to zeolite scientists, following the policies established at recent IZA conferences. We have attempted to be as inclusive as possible to give the users of this publication the maximum information. The structures of the porous solids that we considered comprise corner-sharing tetrahedra, and are not limited to a specific chemical composition. Materials such as metal phosphates and silica polymorphs are included.

The present *Collection* serves as a source of reference patterns for pure zeolite phases. The data will be helpful in establishing the structural purity of experimental phases and in indexing their diffraction patterns. The data will also aid in the determination of changes in the lattice parameters with changing composition, assessing preferred orientation effects, background evaluation, and line broadening. We have also included diffraction patterns of several common dense silicate phases to facilitate their detection in mixed phase syntheses.

The numerical data comprises 2θ values for CuK α radiation ($\lambda = 1.5418$ Å), *d*-spacings, relative intensities, *hkl* Miller indices and multiplicity, M_{hkl} . Data representing 133 framework topologies have been included in this *Collection*. In most cases, X-ray or neutron refinements of hydrated or as-synthesized forms are used.

This edition differs significantly from the 1996 3rd edition which included atomic coordinates. Because of space constraints coordinate data has not been included in this edition, but are available in electronic form, along with the complete contents of this edition, at:

http://www.iza-structure.org/databases/

This web site also contains an interactive powder pattern calculator that allows the user to change the input and variables for a powder pattern calculation.

This book was typeset using LATEX with the standard computer modern typeface. The LATEX file, and associated postscript plots, were generated using a C program written by M. M. J. Treacy.

We wish to acknowledge the assistance and collaboration of the members of the IZA Structure Commission in proofreading the manuscript and for providing additional information. We are indebted to our companies (NEC Research Institute, Inc., and Air Products and Chemicals, Inc.) for support of this project. We are grateful to Peggy Bisher for keeping the reference data files impeccably organized. Finally, we acknowledge the patience and support of our wives Laura and Carol.

Michael M. J. Treacy, Princeton, NJ John B. Higgins, Bad Dog Ridge, PA January 2001



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Additional IZA publications:

Atlas of Zeolite Framework Types, 5th revised edition (2001), Ch. Baerlocher, W. M. Meier and D. H. Olson.

Compilation of Extra Framework Sites in Zeolites (1982), W. J. Mortier. (out of print)

Verified Syntheses of Zeolitic Materials, 2nd revised edition (2001), H. Robson, editor; and K. P. Lillerud, XRD patterns.

See also: http://www.iza-online.org/

EXPLANATORY NOTES

The numerical data and the simulated powder patterns presented in this *Collection* are to a great extent self-explanatory. In order to facilitate the use of these reference patterns some pertinent remarks regarding the keywords used in the data section are summarized below. The input structural data have been deposited on the worldwide web at:

http://www.iza-structure.org/databases/

This *Collection*, including updates, will be accessible at the above address.

ZEOLITE FRAMEWORK TYPES

The three-letter framework type codes, recognized by the IUPAC Commission on Zeolite Nomenclature, have been used to organize the entries in this publication. The powder diffraction data and simulated patterns for the reference structures are listed alphabetically according to the respective framework type code. An index of material names, and associated three-letter codes, is included in the companion volume, the *Atlas of Zeolite Framework Types* (Baerlocher, Meier and Olson (2001)).

COMPOSITION

Compositions are expressed in terms of the full unit cell content. Two compositions are provided. The CHEMICAL COMPOSITION is the nominal material composition provided in the original reference, and is usually obtained from chemical analysis. The REFINED COMPOSITION is derived from the structure refinement. Because of the complexities of structure refinements, the chemical and refined compositions do not always concur. When available, refinements of hydrated zeolites were used to calculate the patterns. For synthetic zeolites, if the zeolite had been synthesized in the presence of organic material, those refinements of the uncalcined products that contained the occluded organic molecules were chosen. The sample locality is given in the case of natural zeolites.

CRYSTAL DATA

Crystal data includes lattice parameters and space group information from the International Tables for Crystallography, 4th revised edition 1995, and incorporates the new e 'double-glide' plane. Consequently, some space group symbols will differ from those listed in the original references. Two entries in this *Collection* are affected by this change; EU-1 (EUO) which has space group symbol *Cmme* (formerly *Cmma*), and gottardiite (NES) which has space group symbol *Cmce* (formerly *Cmca*). The type of refinement, along with the final *R*-values, is listed with the unit cell parameters.

REFERENCE

Reference cites the literature from which the crystal data, atomic coordinates, and temperature factors were obtained. In many cases there are multiple refinements of the same zeolitic material, but because of space limitations not all refinements could be included. We would be appreciative if authors and users would inform us of any errors or omissions. A listing of the references for isotypic species can be found in the *Atlas of Zeolite Framework Types* (Baerlocher, Meier and Olson (2001)). A list of references to structure analyses of zeolites with different cations, up to 1982, is given in the *Compilation of Extra Framework Sites in Zeolites*, W. J. Mortier (1982).

POWDER PATTERN IDENTIFICATION TABLE

A table is provided to assist in the identification of powder patterns of unknown materials. The 2θ (°) values of the three most pronounced low-angle reflections are listed. Usually, these reflections are simply the three strongest peaks. In many instances, a pronounced low-angle reflection will be included, even if it is not among the most intense. In the 3rd edition (1996) of the *Collection* this table was assembled by visual inspection of the computed powder patterns. For this fourth edition (2001) of the *Collection*, the table was generated automatically from the computed diffraction patterns. To achieve good correspondence with the hand-generated table of the 3rd (1996) edition of the *Collection*, a peak intensity weighting function $W(2\theta)$ was used

$$W(2\theta) = 1 + A \exp\left[-(2\theta)^2/2\sigma^2\right].$$
(1)

The parameters were set to A = 10, and $\sigma = 7^{\circ}$. This function is strongly weighted towards the low angle peaks, particularly those below about 10°, which, even if relatively weak, tend to offer a more characteristic fingerprint of a material compared to the abundance of strong peaks that tend to cluster around 25° in most zeolitic materials.

The data for all the materials presented in this work are sorted by increasing 2θ value in the table. To identify an unknown material, measure the 2θ values of the three most pronounced peaks (assigning strong weighting to any pronounced low-angle peaks, particularly those below about 10°) and find those materials with corresponding reflections at those values. This provides a starting point for a more detailed comparison of the experimental and calculated patterns.

CALCULATED POWDER DIFFRACTION DATA

The powder diffraction data include the 2θ -values for CuK α radiation, *d*-spacings, relative intensities $I_{\rm rel}$, Miller indices hkl and multiplicity M_{hkl} , for the strongest 135 reflections with an integrated intensity $I_{\rm rel}$ greater than 0.1. The strongest reflection is set to $I_{\rm rel} = 100$. The scattering factors used for the framework T- and O-atoms in the structure factor computations were those selected by the authors of the original work. If none had been specified, we chose atomic (neutral) scattering factors. No adsorption corrections were applied to the data, and anisotropic temperature factors were converted to isotropic temperature factors $B_{\rm iso}$ (Å²) using equations reported by W. C. Hamilton, Acta Cryst., 12 609–610 (1959).

Materials with the same framework type code (i.e. framework topology) may have very different diffraction patterns, so for some framework type codes several different reference materials have been included. Examples listed under FAU, GIS, MFI and NAT illustrate the extent of the differences observed in the diffraction patterns of materials with identical framework topologies but variations in composition and/or symmetry.

SIMULATED POWDER PATTERNS

The powder patterns for CuK α radiation are reproduced from 0° to 50° 2 θ . The patterns, and associated tables, were calculated using a custom C program written by M. M. J. Treacy. The intensity scale is kept variable to accommodate extreme situations. The intensity range is usually plotted between 0 and $I_{max} = 100$. If only one or a few peaks are very intense, and the rest of the pattern consists of low-intensity reflections, I_{max} is set at a lower value (see ordinate) to show sufficient detail in the low-intensity region of the pattern. The scale of the ordinate is always calibrated in percent relative intensity of the maximum peak height. Frequently, the peak intensities in the plots will not be identical to the integrated intensities listed in the corresponding tables, because of the possibility of overlapping diffraction peaks. A Lorentzian profile was assumed for the calculation of the pattern. The full width at half maximum (FWHM) of all peaks was set to be 0.08° 2 θ . Many real samples will in general give diffraction patterns with broader lines due to instrumental broadening, disorder, or small crystallite size. However, synchrotron powder diffraction data of some zeolite materials exhibit FWHM of less than 0.04° 2 θ .

Because hydrated forms of natural zeolites or as-synthesized forms were used whenever refined atomic parameters were available, the plots should be easily comparable to experimental patterns. In some cases, only structure refinements of dehydrated or calcined forms were available. Significant differences in the intensities of low-angle peaks may be found when comparing the calculated pattern to experimental patterns of hydrated or as-synthesized materials.

Finally, a note of caution. The patterns are useful in helping to establish the structural purity of a zeolite phase, yet they may not always allow one to readily and unambiguously determine the framework type of the sample. This assignment is often not straightforward and may require more sophisticated analyses. W. J. Rohrbaugh and E. W. Wu review the factors affecting the diffraction characteristics of zeolite materials (ACS Symposium Series **411** 279–302 (1989)).

POWDER PATTERN SIMULATIONS OF DISORDERED INTERGROWTHS

A number of zeolitic materials crystallize as disordered planar intergrowths of "end-member" frameworks. Two of the better-studied series are the FAU/EMT intergrowths (such as ZSM-2, ZSM-3, ZSM-20, ECR-30, CSZ-1 and CSZ-3) and the intergrown zeolite beta and its natural analog tschernichite. Powder patterns for five of the more commonly observed coherently intergrown series were calculated using the DIFFaX computer program (M. M. J. Treacy, J. M. Newsam and M. W. Deem, *Proc. R. Soc. Lond.* A **433** 499-520 (1991)). Random stacking faults are assumed. The five series are; the beta family; SSZ-33/SSZ-26; FAU/EMT; MFI/MEL; and OFF/ERI. The stacking fault probability is incremented from 0 to 1 in steps of 0.1. Stacking fault probabilities of 0 and 1 represent the unfaulted end-members.

Additional information on disordered intergrowths can be found in the *Catalog of Disordered Zeolite Structures*, which is available electronically at http://www.iza-structure.org/databases/.

CHANGES SINCE THE THIRD REVISED EDITION

• 35 new framework types have been approved since the third revised edition, and are included in this fourth revised edition. The new framework types are:

ACO	AEN	AFN	ASV	AWO	CFI	CGF
CGS	\mathbf{CZP}	DFT	DON	\mathbf{ESV}	FRA	GON
IFR	ISV	ITE	MSO	MTF	MWW	OSI
OSO	SAO	SAS	SAT	SAV	SBE	SBS
SBT	SFE	SFF	STF	STT	TER	TSC

• Due to space constraints, the refined structure coordinates are not listed in the printed version of this *Collection*. An electronic PDF version of this *Collection*, complete with coordinates, can be found at:

http://www.iza-structure.org/databases/

- Errors in the space group settings of Maricopaite (MOR) and chiavennite (-CHI) have been fixed. These corrections change the diffraction patterns and the listed peak intensities.
- The distance least squares refinement of liottite (LIO), given in the third revised edition, has been replaced by a single crystal x-ray refinement.
- The entry for Na-exchanged K-F (EDI) has been removed due to inconsistencies in the refinement.
- A typographic error in the published coordinates for perlialite (LTL) has been corrected. This correction has changed the diffraction pattern noticeably.
- An error in the cation occupancies for the mineral faujasite (FAU) has been corrected. This correction has changed the diffraction pattern noticeably.
- The refinements of MAPO-39 (ATN) and offretite (OFF) have been replaced.
- A refinement for low silica zeolite-X (FAU) has been added.
- A small number of typographic errors in atom coordinates have been corrected.

POWDER PATTERN IDENTIFICATION TABLE

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Powder Pattern Identification Table

2 <i>0</i> °	Material	Code
3.33	Franzinite	FRA
3.42	Cloverite	-CLO
3.56	Paulingite	PAU
4.14	NaZ-21	LTN
4.56	Decamethonium DAF-1	DFO
4.80	VPI-9	VNI
4.83	Cloverite	-CLO
4.84	Tschörtnerite	TSC
5.04	Paulingite	PAU
5.31	AIPO-8	AET
5.38	VPI-5	VFI
5 50	Perlialite	LTL
5 55	Linde Type L	LTL.
5 55	Mazzite	MAZ
5 50	Techortporito	TSC
5.09	UCSD 9Co	SDE
5.00	Chistophite	CHI
5.04	UCSP 6CoCo	eDe
5.74	MOM 25	MTE
0.10 5 07	MCM-35	ENT
5.57	EMC-2, Calcined	ENT
0.87	EMC-2, Partially Denydrated	EMT
5.92	Cloverite	-CLO
5.96	LI-LSA	FAU
6.02	UCSB-10GaZn	SBT
6.04	UTD-1	DON
6.10	Na-X, Dehydrated	FAU
6.12	Na-X, Hydrated	FAU
6.19	Faujasite	FAU
6.23	EMC-2, Partially Dehydrated	EMT
6.24	EMC-2, Calcined	EMT
6.31	Na-Y, Siliceous	FAU
6.32	UCSB-10GaZn	SBT
6.33	Ultrastable Y, Dehydrated Dealuminated	FAU
6.39	Maricopaite	MOR
6.41	UCSB-8Co	SBE
6.48	1-aminoadamantane Deca-Dodecasil 3R	DDR
6.50	UCSB-6GaCo	SBS
6.51	Mordenite	MOR
6.57	AlPO-8	AET
6.57	Di-n-propylamine MAPSO-46	AFS
6.58	UCSB-6GaCo	SBS
6.58	SSZ-48, Calcined	SFE
6.65	EMC-2, Calcined	EMT
6.65	EMC-2, Partially Dehydrated	EMT
6.69	(Cs,K) ZK5, Dehydrated	KFI
6.77	NaZ-21	LTN
6.78	VPI-8	VET
6.82	UiO-6. Calcined	OSI
6.82	Roggianite	RON
6.85	AIPO-41 Calcined	AFO
6.88	ITO-7. Siliceous, Calcined	ISV
6.93	CIT-5	CFI
6.96	GUS-1	GON
6 08	Beta Polymorph A SiOn Framework	*RFA
7 01	ITO-7 Silicous Calcined	ISV
7 04	HCSB, 10Ca7n	SBT
7.05	NIL-87	NEG
7.00	ITO-1 Calcined (Siliscom MCM 99)	MANA
7 10	Barullonhornhate H	
7 1 9	ITO 1 Calainad (Silianaus MCM 99)	ог п Мини
1.10	i i w-i, Oalemeu (oniceous MOM-22)	TAT AA AA

200	Material	Code
718	Linde Type A Hydrated	ITA
7 20	Linde Type A, Hydrated	ITA
7 33	CIT 5	CEI
7.40	Terranouzito	TED
7 41	N Dineridine Dedensell 111	DOU
7.41	N2, riperidine Dodecasii In	DUH
7.42	SAPO-36	AFX
1.42	Gmeinnte	GME
1.43	Boggsite	BOG
1.43	Tetrapropylammonium Fluoride AIPO-5	AFI
7.47	ZSM-12, Calcined	MTW
7.49	MCM-61	MSO
7.55	UTD-1	DON
7.61	Tetrapropylammonium SAPO-40	AFR
7.63	ZSM-12, Calcined	MTW
7.66	Offretite	OFF
7.66	CIT-1	CON
7.67	STA-1, Magnesium Aluminophosphate	SAO
7.68	1-aminoadamantane Deca-Dodecasil 3R	DDR
7.69	Erionite	ERI
7.71	Bellbergite	EAB
7.71	Piperidine AlPO-17	ERI
7.72	ITQ-7, Siliceous, Calcined	ISV
7.72	Di-n-propylamine MAPSO-46	AFS
7.72	SSZ-44, Calcined	SFF
7.73	ERS-7 Framework	ESV
7.74	Beta Polymorph A SiO ₂ Framework	*BEA
7.75	ZSM-18 SiOn Framework	MEI
7 78	Ferrierite	FER
7.80	Gottardiite	NES
7.82	ZSM-57 SiOn Framework	MFS
7.84	Boggsite	BOG
7.84	CIT-1	CON
7.88	MAPO-36 Calcined	ATS
7.80	Dodecasil 3C	MTN
7 90	NIL87	NES
7.01	Decamethonium DAF 1	DEO
7.02	FU-1 Calcined Rehydroted	FUO
7.03	7SM.11 Calcined	MEI
7.04	No7 01	TTN
7.04	7SM 5 Calairad	MEI
7.94	Ammunium Elustide 78M 02	
7.05	Tetrophenular anium 78M f	MET
7.55	2 emineration Numeril	NON
7 00	SS7.35 Calcinod	SUDE
1.99	ZSM 5 Calcined	J I F
0.01	Di Di CARCINEO	IVIT I
0.01	ITO 1 Calairad (Siling MOM 20)	AF 1 N433/337
0.01	HQ-1, Calcined (Sinceous MCM-22)	
0.02	Air 0-52, Calcined, Rehydrated	AFT
8.06	ietrapropylammonium SAPO-40	AFR
8.06	S54-44, Ualcined	SFF
8.07	554-48, Calcined	SFE
8.09	S52-35, Calcined	STF
8.09	Di-isopropylamine MnAPO-11	AEL
8.10	AIPO-11, Calcined	AEL
8.11	ERS-7 Framework	ESV
8.11	SSZ-23	STT
8.11	Beryllophosphate-H	BPH
8.15	Decamethonium DAF-1	DFO
8.15	HQ-4, Calcined	IFR
8.15	Diethylamine Theta-1 (Silica ZSM-22)	TON

20°	Material	Code
8.17	STA-1, Magnesium Aluminophosphate	SAO
8.20	Cobalt Gallium Phosphate-6	CGS
8.20	MAPO-36, Calcined	ATS
8.21	Partheite	-PAR
8.22	Ammonium Fluoride ZSM-23	MTT
8.32	Gottardiite	NES
8.32	Rho. Hydrated	RHO
8.37	NU-87	NES
8 49	Di-n-propylamine SAPO-31	ATO
8 56	Levvne	LEV
8 58	ITO-3 Calcined	ITE
8.62	Terranoveite	TED
8.64	SAPO56	AFY
8.64	BUB 13	DTU
0.04	1 aminoadamantana NU 2	IEV
0.00	1-annoadamantane NU-3	LE V CED
0.11	DUD 17	DCN
0.72	RUD-17	RSN
8.13		SAS
8.75	EU-1, Calcined, Rehydrated	EUO
8.81	lerranovaite	TER
8.81	ZSM-11, Calcined	MEL
8.82	GUS-1	GON
8.84	Tetrapropylammonium ZSM-5	MFI
8.87	VPI-7	\mathbf{vsv}
8.88	Tetrapropylammonium ZSM-5	MFI
8.90	ZSM-5, Calcined	MFI
8.91	ZSM-12, Calcined	MTW
8.93	Rho, Deuterated Berylloarsenate	RHO
8.94	Lovdarite	LOV
8.95	Ammonium Fluoride ZSM-23	MTT
8.98	Maricopaite	MOR
9.01	ITQ-3, Calcined	ITE
9.01	1-aminoadamantane Sigma-2	SGT
9.05	RUB-13	RTH
9.07	Pahasapaite	RHO
9.08	AlPO-14, Calcined	AFN
9.10	CIT-1	CON
9.14	AIPO-C, Hydrated	APC
9.16	RUB-3	RTE
9.18	Quinuclidine AIPO-22	AWW
9.23	Ferrierite	FER
9.23	Cobalt Gallophosphate	LAU
9.24	Laumontite	LAT
9.28	UCSB-8Co	SBE
9.30	Tetramethylammonium OH AlPO-12	ATT
9.36	Magnesium STA-7	SAV
9.00	AIPO_25	ATV
0.38	Leonhardite	LAU
0.40	Chabazite	CHA
9.40	7SM 57 SiO- Framework	MEG
0.40	Magnesium STA 7	CAV
9.42	Regression 31A*/	SAV Sede
9.43	Dodredo, Calcined	or E Fed
9.40	Di inangenulamine Mar ADO 11	ADI
9.40	MADO 20	ABL
9.47	MARU-39 (C-V) 7Vr Debudented	AIN
9.41	(US, K) LAD, Denyarated	AFI OUT
9.48	Methyloutylamine SAPO-47	UHA
9.49	AirO-18, Calcined	AEI
9.49	Belibergite	EAB
9.50	552-23	STT

20°	Material	Code
9.54	AlPO-52, Calcined, Rehydrated	AFT
9.54	Perlialite	LTL
9.55	ZSM-18, SiO ₂ Framework	MEI
9.57	AlPO-11, Calcined	AEL
9.59	VPI-8	VET
9.61	2-aminopentane Nonasil	NON
9.62	Mazzite	MAZ
9.64	(Na, Tetramethylammonium)-E	EAR
9.65	UiO-6, Calcined	OSI
9.65	Roggianite	-RON
9.68	Erionite	ERI
9.68	Beta, Polymorph A SiO ₂ Framework	*BEA
9.69	Tschörtnerite	TSC
9.69	ITQ-4, Calcined	IFR
9.70	Stilbite	STI
9.71	Stellerite	STI
9.72	Barrerite	STI
9.72	AlPO-41. Calcined	AFO
9.73	SSZ-35, Calcined	STF
9.74	Li-LSX	FAU
9.75	MCM-35	MTF
9.75	Chiral Sodium Zincophosphate P6,22	CZP
9.77	Mordenite	MOR
9.77	Piperidine AIPO-17	EBI
9.81	Chiral Sodium Zinconhoenhate P6.22	CZP
9.81	Di-n-propylamine CoAPO-50	AFV
9.82	ERS-7 Framework	ESV
9.85	Heulandite	HEII
0.88	Clinoptilolite	UPU
0.00	Stellerite	STI
0.01	Barrarite	STI
0.05	Dachiardita	DAC
0.06	Stilbite	STI
9.97	Enistilbite	EPI
9.97	Na-X Dehydrated	FATI
9.99	AIPO-8	AET
10.00	Cobalt Gallium Phoenhate 5	CGF
10.00	No-X Hydrotod	FAII
10.00	RUB-10 SiOs Framework	DUT
10.00	ITO-3 Calcined	ITE
10.00	ASU-7	ASV
10.01	Tetramethylammonium ZAPO-M1	70N
10.00		AWO
10.10	OSB-1	050
10.14	AIPO-EN3	AEN
10.14	VPL0	VNI
10.16	Diethylamine Theta-1 (Silica 7SM-22)	TON
10.17	Linde Type A Hydrated	LTA
10.11	BUB-13	DTU
10.10	Linda Type A Debydrated	LTA
10.13	MCM-61	MSO
10 21	Na-Y Siliceous	FATI
10.34	Illtrastable V. Dehydrated Dealuminated	FAU
10.34	AIPO - H2	AHT
10.49	Magnesium STA-7	SAV
10.50	STA_6	SAC
10.50	\$\$7.93	STT
10.30	AIPO-18 Calcined	APT
10.01	An O-10, Usuchieu Paulingite	DATI
10.75	Nepheline Hydrate	JBW

20°	Material	Code
10.77	RUB-10, SiO ₂ Framework	RUT
10.77	VPI-5	VFI
10.85	Levyne	LEV
10.90	Harmotome	PHI
10.90	Partheite	-PAR
11.07	Heulandite	HEU
11.08	1-aminoadamantane NU-3	LEV
11.11	Mazzite	MAZ
11.17	ZSM-18, SiO ₂ Framework	MEI
11.19	Clinoptilolite	HEU
11.29	Bikitaite	BIK
11.30	Chiavennite	-CHI
11.33	Cobalt Gallium Phosphate-5	CGF
11.38	Chiral Sodium Zincophosphate, P6122	CZP
11.41	Chiral Sodium Zincophosphate, P6522	CZP
11.42	Li-LSX	FAU
11.43	Barium Chloroaluminosilicate	MER
11.45	Quinuclidine AIPO-16	AST
11.49	Cobalt Gallium Phosphate-6	CGS
11.52	Gmelinite	GME
11.53	Levyne	LEV
11.54	Losod	LOS
11.57	AIPO-14, Calcined	AFN
11.57	SAPO-56	AFX
11.64	AIPO-52, Calcined, Rehydrated	AFT
11.65	Onretite	UFF A RT
11.67	Quinuciidinium fluoride octadecasii	AST FATI
11.09	Na-A, Denyaratea Na X, Hudaatad	FAU
11.13	Ina-A, nyaratea Lindo Tuno I	LTI
11.70	Naphalina Hydrata	IBW
11.79	Represente regulate	FATI
11.80	raujasite Wankita	WEN
11.00	Magnasium Phosphata USO-90	DFT
19 10	Na ₂ V Siliceous	FATI
12.10	Amicita	GIS
12.10	Illtrastable Y Dehydrated Dealuminated	FAU
12.14	Gismondine	GIS
12.22	AIPO-21	AWO
12.22	ACP-1	ACO
12.32	Cobalt Gallium Phosphate-6	CGS
12.35	Gobbinsite	GIS
12.36	Phillipsite	PHI
12.38	Garronite	GIS
12.38	Di-n-propylamine MAPO-43	GIS
12.40	Harmotome	PHI
12.41	Goosecreekite	GOO
12.42	Tetrapropylammonium SAPO-40	AFR
12.44	Merlinoite	MER
12.44	Tetramethylammonium ZAPO-M1	ZON
12.46	Na-P1	GIS
12.46	Linde Type A, Hydrated	LTA
12.48	Phillipsite	PHI
12.49	Linde Type A, Dehydrated	LTA
12.54	Merlinoite	MER
12.55	AlPO-C, Dehydrated	APC
12.57	Gobbinsite	GIS
12.58	Ferrierite, Siliceous	FER
12.59	Goosecreekite	GOO
12.60	ACP-1	ACO

20°	Material	Code
12.65	Tetramethylammonium OH AlPO-12	ATT
12.71	Laumontite	LAU
12.73	MCM-61	MSO
12.76	Franzinite	FRA
12.78	ZSM-57, SiO ₂ Framework	MFS
12.78	Dachiardite	DAC
12.80	Maricopaite	MOR
12.83	Ferrierite, Siliceous	FER
12.84	Epistilbite	EPI
12.88	RUB-17	RSN
12.89	Methylbutylamine SAPO-47	CHA
12.90	AlPO–C, Hydrated	APC
12.91	Dodecasil 3C	MTN
12.91	AlPO-D	APD
12.91	AlPO-18, Calcined	AEI
12.99	AIPO-EN3	AEN
13.00	Leonhardite	LAU
13.07	Brewsterite	BRE
13.15	AlPO-14, Calcined	AFN
13.16	Lovdarite	LOV
13.17	Di-n-propylamine MAPSO-46	AFS
13.33	(Na, Tetramethylammonium)-E	EAB
13.34	Erionite	ERI
13.37	Scolecite	NAT
13.38	Piperidine AIPO-17	ERI
13.39	1 homsonite	MON
13.41	Montesommaile MADO 20	ATUNI
13.41	MAPO-39 Connerdite	NAT
13.41	Movalita	NAT
13.44	Mordenite	MOR
13.50	Bellbergite	EAB
13.56	Natrolite	NAT
13.60	Edingtonite	EDI
13.64	AlPO-C. Hydrated	APC
13.72	ITQ-4, Calcined	IFR
13.72	Losod	LOS
13.73	AlPO-41, Calcined	AFO
13.76	Tetramethylammonium ZAPO-M1	ZON
13.80	Li-ABW	ABW
13.88	RUB-17	RSN
13.89	STA-1, Magnesium Aluminophosphate	SAO
13.89	VPI-7	vsv
13.90	Harmotome	PHI
14.00	AlPO-C, Dehydrated	APC
14.02	Cancrinite	CAN
14.02	Brewsterite	BRE
14.14	RUB-3	RIE
14.10	Sodalite Octanydrate	SOD
14.31	PUB 10 SiO. Framework	BUT
14.41	Rogranite	RON
14.56	Partheite	-PAR
14.71	Linde Type L	LTL
14.74	Melanophlogite	MEP
14.80	AlPO-21	AWO
14.96	Gonnardite	NAT
14.96	AIPO-25	ATV
14.97	Weinebeneite	WEI
15.00	(Cs,K) ZK5, Dehydrated	KFI

15.04NatroliteNAT15.10ScoleciteNAT15.10N, Piperidine Dodecasil 1HDOH15.11MesoliteNAT15.12Chiavennite-CHI15.23FerrieriteFER15.24Chiavennite-CHI15.25Chiral Sodium Zincophosphate, P6;22CZP15.27Chiral Sodium Zincophosphate, P6;22CZP15.37YugawaraliteYUG15.42OSB-1OSO15.45WeinebeneiteWEI15.61FaujasiteFAU15.61FaujasiteFAU15.61FaujasiteFAU15.61FaujasiteMEP16.24STA-6SAS16.34STA-2SAT16.45MelanophlogiteMER16.44STA-2SAT16.57MerlinoiteMER16.84N2, Piperidine Dodecasil 1HDOH17.35AmiciteGIS17.85GmeliniteGIS17.86GarroniteGIS17.87RUB-3RTE17.80AlPO-C, DehydratedAPC18.40AfghaniteAFG18.51LiottiteLIO18.64LiosodLOS18.75Quinuclidine AlPO-16AST19.06MAPO-36, CalcinedATS19.15CancriniteCAN19.24TomsoniteTHO19.24TomsoniteTHO19.25L-aminoadamantane Sigma-2SGT <t< th=""><th>20°</th><th>Material</th><th>Code</th></t<>	20°	Material	Code
15.10ScoleciteNAT15.10N2, Piperidine Dodecasil 1HDOH15.11MesoliteNAT15.14Dodecasil 3CMTN15.20Chiavannite-CHI15.23FerrieriteFER15.26Chiral Sodium Zincophosphate, P6,22CZP15.27Chiral Sodium Zincophosphate, P6,22CZP15.30YugawaraliteYUG15.42OSB-1OSO15.45WeinebeneiteWEI15.61FaujasiteFAU15.81AnalcimeANA16.16MelanophlogiteMEP16.24STA-6SAS16.34STA-2SAT16.57MerlinoiteMER16.42STA-2SAT16.57MerlinoiteMER16.43N2, Piperidine Dodecasil 1HDOH17.35AmiciteGIS17.85GmeliniteGIS17.82LovdariteLOV17.87GarroniteGIS18.35LiottiteLIO18.40AfghaniteAFG18.35LiottiteLIO18.40AfghaniteAFG19.56I-aminoadamantane Sigma-2SGT19.16YugawaraliteYUG19.21ThomsoniteEDI19.32GooscereekiteGOO20.01Moganite-20.02AWWZ20.34GotardiiteAFG19.35Calcined, RehydratedFHO19.36<	15.04	Natrolite	NAT
15.10 N_2 , Piperidine Dodecasil 1HDOH15.11MesoliteNAT15.14Dodecasil 3CMTN15.20Chiavennite-CHI15.20Chiral Sodium Zincophosphate, $P6_522$ CZP15.27Chiral Sodium Zincophosphate, $P6_122$ CZP15.30YugawaraliteYUG15.42OSB-1OSO15.45WeinebeneiteWEI15.61FaujasiteFAU15.81AnalcimeANA16.16MelanophlogiteMEP16.24STA-6SAS16.34STA-2SAT16.45MerinoiteMER16.57MerlinoiteMER16.84N2, Piperidine Dodecasil 1HDOH17.131-aminoadamantane Deca-Dodecasil 3RDDR17.35AmiciteGIS17.85GarroniteGIS17.90AIPO-C, DehydratedAPC18.40AfghaniteLOS18.51LiottiteLIO18.40AfghaniteAFG18.51CancriniteCAN19.15CancriniteCAN19.15CancriniteCAN19.16MAPO-36, CalcinedATS19.17ServekiteGOO20.01Moganite-20.02CH-5CFI20.03Dien-propylamine SAPO-31ATO20.34GotardiiteCHA20.35Ethylamine Theta-1 (Silica ZSM-22)TON20.45ChabaziteCHA<	15.10	Scolecite	NAT
15.11MesoliteNAT15.11Mesolite-CHI15.20Chiavennite-CHI15.23FerrieriteFER15.26Chiral Sodium Zincophosphate, P6, 22CZP15.27Chiral Sodium Zincophosphate, P6, 22CZP15.27Chiral Sodium Zincophosphate, P6, 22CZP15.30YugawaraliteYUG15.42OSB-1OSO15.45WeinebeneiteWEI15.61FaujasiteFAU15.81AnakcimeANA16.16MelanophlogiteMEP16.24STA-6SAS16.34STA-2SAT16.42STA-2SAT16.43STA-2SAT16.44STA-2SAT16.57MerlinoiteMER17.35AmiciteGIS17.35AmiciteGIS17.35AmiciteGME17.82LovdariteLOV17.87RUB-3RTE17.87GaroniteGIS18.35LiottiteLIO18.40AfghaniteAFG18.54Quinuclidine AIPO-22AWW18.61LosodLOS18.76Rho, HydratedRHO18.77Quinuclidine AIPO-16AST19.16CancriniteCAN19.16CancriniteCAN19.16CancriniteGOO20.09VP1-8VET20.18Di-n-propylamine SAPO-31ATO20.36Diethylamine	15.10	N ₂ , Piperidine Dodecasil 1H	DOH
15.14 Dodecasil 3C MTN 15.20 Chiavennite -CHI 15.23 Ferrierite FER 15.26 Chiral Sodium Zincophosphate, P6,22 CZP 15.27 Chiral Sodium Zincophosphate, P6,22 CZP 15.40 OSD SSD 15.42 OSB-1 OSO 15.45 Weinebeneite WEI 15.46 Faujasite FAU 15.81 Analcime ANA 16.16 Melanophlogite MEP 16.24 STA-6 SAS 16.34 STA-2 SAT 16.42 STA-2 SAT 16.57 Merlinoite MER 16.58 N2, Piperidine Dodecasil 1H DOH 17.35 Amicite GIS 17.85 Gmelinite GME 17.85 Garonite GIS 17.87 RUB-3 RTE 17.87 Garonite GIS 17.80 AlPO-C, Dehydrated APC 18.40 Afghanite AFG 18.40 <t< td=""><td>15.11</td><td>Mesolite</td><td>NAT</td></t<>	15.11	Mesolite	NAT
15.20 Chiavennite -CHI 15.23 Ferrierite FER 15.26 Chiral Sodium Zincophosphate, P6, 22 CZP 15.30 Yugawaralite YUG 15.42 OSB-1 OSO 15.45 Weinebeneite WEI 15.61 Faujasite FAU 15.61 Faujasite MEP 16.16 Melanophogite MEP 16.24 STA-6 SAS 16.33 STA-2 SAT 16.42 STA-6 SAS 16.34 STA-2 SAT 16.42 STA-2 SAT 16.84 N2, Piperidine Dodecasil 1H DOH 17.35 Amicite GIS 17.85 Gmelinite COV 17.87 Roronite GIS 17.87 RuB-3 RTE 17.87 Garonite GIS 18.35 Liottite LIO 18.40 Afghanite AFG 18.54 Quinuclidine AlPO-16 AST 18.59 Edingtonite <t< td=""><td>15.14</td><td>Dodecasil 3C</td><td>MTN</td></t<>	15.14	Dodecasil 3C	MTN
15.23FerrieriteFER15.26Chiral Sodium Zincophosphate, P6,22CZP15.27Chiral Sodium Zincophosphate, P6,22CZP15.30YugawaraliteYUG15.42OSB-1OSO15.43WeinebeneiteWEI15.61FaujasiteFAU15.81AnaleimeANA16.16MelanophlogiteMEP16.24STA-6SAS16.34STA-2SAT16.42STA-2SAT16.57MerlinoiteMER16.48N2, Piperidine Dodecasil 1HDOH17.13I-aminoadamantane Deca-Dodecasil 3RDDR17.35AmiciteGIS17.82LovdariteLOV17.87GarroniteGIS17.80AlPO-C, DehydratedAPC18.04GismondineGIS18.35LiottiteLIO18.40AfghaniteAPG18.54Quinuclidine AlPO-22AWW18.61LosodLOS18.75Quinuclidine AlPO-16AST19.06MAPO-36, CalcinedATS19.15CancriniteCAN19.16YugawaraliteYUG19.21ThomsoniteTHO19.24HomsoniteNES20.36CitaliteMED20.41GoscereekiteGOO20.41GoscereekiteCFI20.42Armonadamantane Sigma-2SGT19.561-aminoadamantane Sigma-2SGT20.36	15.20	Chiavennite	-CHI
15.26 Chiral Sodium Zincophosphate, P6,22 CZP 15.30 Yugawaralite YUG 15.42 OSB-1 OSO 15.45 Weinebeneite WEI 15.46 Faujasite FAU 15.47 OSA ANA 15.48 Analcime ANA 15.49 STA-6 SAS 16.16 Melanophlogite MEP 16.24 STA-2 SAT 16.42 STA-2 SAT 16.43 STA-2 SAT 16.57 Merlinoite MER 16.57 Merlinoite GIS 17.35 Amicite GIS 17.35 Amicite GIS 17.85 Garonite GIS 17.87 RUB-3 RTE 17.88 Lovdarite LOV 17.87 RUPO-C, Dehydrated APC 18.04 Gismondine GIS 17.85 Quinuclidine AIPO-16 AST 18.40 Afghanite AIG 18.54 Quinuclidine AIPO-16 AS	15.23	Ferrierite	FER
15.27Chiral Sodium Zincophosphate, P6122CZP15.30YugawaraliteYUG15.42OSB-1OSO15.45WeinebeneiteWEI15.61FaujasiteFAU15.61FaujasiteMEP16.24STA-6SAS16.34STA-2SAT16.42STA-6SAT16.43STA-2SAT16.44STA-2SAT16.57MerlinoiteMER16.84N2, Piperidine Dodecasil 1HDOH17.131-aminoadamantane Deca-Dodecasil 3RDDR17.35AmiciteGIS17.65GmeliniteLOV17.87RUB-3RTE17.87RUB-3RTE17.80AlPO-C, DehydratedAPC18.04GismondineGIS18.35LiottiteLIO18.40AfghaniteAFG18.54Quinuclidine AlPO-16AST18.89EdingtoniteEDI19.06MAPO-36, CalcinedATS19.15CancriniteCAN19.21ThomsoniteTHO19.36L-aminoadamantane Sigma-2SGT19.47LawaraliteYUG19.561-aminoadamantane Sigma-2SGT19.761-aminoadamantane Sigma-2SGT19.761-aminoadamantane Sigma-2SGT19.761-aminoadamantane Sigma-2SGT19.761-aminoadamantane Sigma-2SGT19.761-aminoadamantane Sigma-2SGT	15.26	Chiral Sodium Zincophosphate, P6522	CZP
15.30YugawaraliteYUG15.42OSB-1OSO15.45WeinebeneiteWEI15.61FaujasiteFAU15.61FaujasiteMEP16.24STA-6SAS16.34STA-2SAT16.42STA-2SAT16.42STA-2SAT16.43STA-2SAT16.44N2, Piperidine Dodecasil 1HDOH17.131-aminoadamantane Deca-Dodecasil 3RDDR17.35AmiciteGIS17.85GmeliniteGIS17.86GarconiteGIS17.87RUB-3RTE17.87RUB-3RTE17.87GarconiteGIS17.80AlPO-C, DehydratedAPC18.40AfghaniteLIO18.40AfghaniteAFG18.54Quinuclidine AlPO-22AWW18.61LosodLOS18.75Quinuclidine AlPO-16AST19.86RhOHy019.15CancriniteCAN19.21ThomsoniteTHO19.561-aminoadamantane Sigma-2SGT19.761-aminoadamantane Sigma-2SGT19.82GoosecreekiteGOO20.01Moganite-20.88CitardiiteNES20.36Diethylamine Theta-1 (Silica ZSM-22)TON20.36Diethylamine Theta-1 (Silica ZSM-22)TON20.36Diethylamine Theta-1 (Silica ZSM-22)TON20.36Diethyl	15.27	Chiral Sodium Zincophosphate, P6122	CZP
15.42OSD15.45WeinebeneiteWEI15.61FaujasiteFAU15.81AnalcimeANA16.16MelanophlogiteMEP16.24STA-6SAS16.34STA-2SAT16.42STA-2SAT16.42STA-2SAT16.42STA-2SAT16.42STA-2SAT16.42STA-2SAT16.43N2, Piperidine Dodecasil 1HDOH17.131-aminoadamantane Deca-Dodecasil 3RDDR17.85GmeliniteGME17.85GarconiteLOV17.87RUB-3RTE17.80AlPO-C, DehydratedAPC18.04GismondineGIS18.35LiottiteLIO18.40AfghaniteAFG18.54Quinuclidine AlPO-22AWW18.61LosodLOS18.67Rho, HydratedRHO18.75Quinuclidine AlPO-16AST18.89EdingtoniteEDI19.06MAPO-36, CalcinedATS19.15CancriniteCAN19.16YugawaraliteYUG19.21ThomsoniteTHO19.82GoosecreekiteGOO20.01Moganite-20.80CIT-5CFI20.81CotardiiteNES20.32EU-1, Calcined, RehydratedEUO20.34GottardiiteNES20.35EU-1, Calcined, RehydratedEUO<	15.30	Yugawaralite	YUG
15.45WeinebeneiteWEI15.61FaujasiteFAU15.81AnalcimeANA16.16MelanophlogiteMEP16.24STA-6SAS16.34STA-2SAT16.42STA-2SAT16.43STA-2SAT16.44STA-2SAT16.45MelinoiteMER16.84N2, Piperidine Dodecasil 1HDOH17.131-aminoadamantane Deca-Dodecasil 3RDDR17.35AmiciteGIS17.65GmeliniteLOV17.87RUB-3RTE17.87RUB-3RTE17.87RUB-3RTE17.87GarroniteGIS17.90AlPO-C, DehydratedAPC18.04GismondineGIS18.35LiottiteLIO18.40AfghaniteAFG18.54Quinuclidine AlPO-16AST18.89EdingtoniteEDI19.06MAPO-36, CalcinedATS19.15CancriniteCAN19.16YugawaaliteYUG19.21ThomsoniteTHO19.34GotardiiteGOO20.09VPI-8VET20.18Di-n-propylamine SAPO-31ATO20.34GotardiiteNES20.35EU-1, Calcined, RehydratedEUO20.45ChabaziteCHA20.52Tridymite-20.53EU-1, Calcined, RehydratedEUO20.54Chabazite <td>15.42</td> <td>OSB-1</td> <td>oso</td>	15.42	OSB-1	oso
15.61FaujasiteFAU15.61FaujasiteMEP16.16MelanophlogiteMEP16.24STA-6SAS16.34STA-2SAT16.42STA-2SAT16.42STA-2SAT16.42STA-2SAT16.42STA-2SAT16.43N2, Piperidine Dodecasil 1HDOH17.131-aminoadamantane Deca-Dodecasil 3RDDR17.35AmiciteGIS17.65GreliniteGIS17.87RUB-3RTE17.87GarroniteGIS17.87GarroniteGIS18.35LiottiteLOV18.40AfghaniteAFC18.54Quinuclidine AIPO-22AWW18.61LosodLOS18.67Rho, HydratedRHO18.79Quinuclidine AIPO-16AST19.96MAPO-36, CalcinedATS19.15CancriniteCAN19.16YugawraliteYUG19.21ThomsoniteTHO19.561-aminoadamantane Sigma-2SGT19.761-aminoadamantane Sigma-2SGT19.82GoosecreekiteGOO20.03Dien-propylamine SAPO-31ATO20.34GottardiiteNES20.35EU-1, Calcined, RehydratedEUO20.54Tridymite-20.55Tridymite-20.62Aimole, AIPO-22AWW20.62Aimole, AIPO-22AWW	15.45	Weinebeneite	WEI
15.81AnalcimeANA16.16MelanophlogiteMEP16.24STA-6SAS16.34STA-2SAT16.42STA-2SAT16.42STA-2SAT16.43STA-2SAT16.44STA-2SAT16.45MelinoiteMER16.46STA-2SAT16.47STA-2SAT16.48N2, Piperidine Dodecasil 1HDOH17.131-aminoadamantane Deca-Dodecasil 3RDDR17.35AmiciteGIS17.35AmiciteLOV17.87GaroniteGIS17.82LovdariteLOV17.87RUB-3RTE17.87GaroniteGIS17.90AlPO-C, DehydratedAPC18.04GismondineGIS18.35LiottiteLIO18.40AfghaniteAFG18.54Quinuclidine AlPO-12AWW18.61LosodLOS18.75Quinuclidine AlPO-16AST18.89EdingtoniteEDI19.15CancriniteYUG19.21ThomsoniteTHO19.22ThomsoniteTHO19.23CoosecrekiteGOO20.04Moganite-20.36Diethylamine Theta-1 (Silica ZSM-22)TON20.45ChabaziteCHA20.52Tridymite-20.53EU-1, Calcined, RehydratedEUO20.54ChabaziteCHA </td <td>15.61</td> <td>Faujasite</td> <td>FAU</td>	15.61	Faujasite	FAU
16.16MelanophlogiteMEP16.24STA-6SAS16.34STA-2SAT16.42STA-2SAT16.42STA-2SAT16.57MerlinoiteMER16.57MerlinoiteMER16.84N2, Piperidine Dodecasil 1HDOH17.131-aminoadamantane Deca-Dodecasil 3RDDR17.35AmiciteGIS17.65GmeliniteGME17.82LovdariteLOV17.87RuB-3RTE17.87GarroniteGIS17.87GaroniteGIS18.35LiottiteLIO18.40AfghaniteAFG18.54Quinuclidine AIPO-22AWW18.61LosodLOS18.75Quinuclidine AIPO-16AST18.89EdingtoniteEDI19.06MAPO-36, CalcinedATS19.15CancriniteCAN19.21ThomsoniteTHO19.561-aminoadamantane Sigma-2SGT19.761-aminoadamantane Sigma-2SGT19.82GoosecreekiteGOO20.03Diethylamine Theta-1 (Silica ZSM-22)TON20.34Gottardiite-20.35EU-1, Calcined, RehydratedEUO20.53EU-1, Calcined, RehydratedEUO20.54Tridymite-20.62AiPO-DAPD20.64UiO-6, CalcinedOSI20.65CindeOSI20.66GUS-1	15.81	Analcime	ANA
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19:21Thomsonite1HO19:561-aminoadamantane Sigma-2SGT19:761-aminoadamantane Sigma-2SGT19:82GoosecreekiteGOO20.01Moganite-20.08CIT-5CFI20.09VPI-8VET20.18Di-n-propylamine SAPO-31ATO20.34GottardiiteNES20.35Diethylamine Theta-1 (Silica ZSM-22)TON20.45ChabaziteCHA20.53EU-1, Calcined, RehydratedEUO20.58Tridymite-20.61Quinuclidine AIPO-22AWW20.62AiPO-DAPD20.64UiO-6, CalcinedOSI20.65GUS-1GON20.66GUS-1GON20.67APDAPD20.82GismondineGIS	19.16	Yugawaralite	YUG
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19.76I-aminoadamantane Sigma-2SG119.82GoosecreekiteGOO20.01Moganite-20.08CIT-5CFI20.09VPI-8VET20.18Di-n-propylamine SAPO-31ATO20.34GottardiiteNES20.35Diethylamine Theta-1 (Silica ZSM-22)TON20.45ChabaziteCHA20.53EU-1, Calcined, RehydratedEUO20.58Tridymite-20.61Quinuclidine AIPO-22AWW20.622-aminopentane NonasilNON20.62Methylbutylamine SAPO-47CHA20.64UiO-6, CalcinedOSI20.66GUS-1GON20.71AIPO-DAPD20.82GismondineGIS	19.56	I-aminoadamantane Sigma-2	SGT
19.82 Goosecreekte GOO 20.01 Moganite - 20.08 CIT-5 CFI 20.09 VPI-8 VET 20.34 Gottardiite NES 20.35 Diethylamine Theta-1 (Silica ZSM-22) TON 20.45 Chabazite CHA 20.52 Tridymite - 20.53 EU-1, Calcined, Rehydrated EUO 20.54 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 Methylbutylamine SAPO-47 CHA 20.64 UiO-6, Calcined OSI 20.65 GUS-1 GON 20.64 UiO-6, Calcined OSI 20.65 Gismondine GIS	19.76	I-aminoadamantane Sigma-2	SGT
20.01 Moganite - 20.08 CIT-5 CFI 20.09 VPI-8 VET 20.18 Di-n-propylamine SAPO-31 ATO 20.34 Gottardiite NES 20.35 Diethylamine Theta-1 (Silica ZSM-22) TON 20.45 Chabazite CHA 20.52 Tridymite - 20.53 EU-1, Calcined, Rehydrated EUO 20.54 Tridymite - 20.61 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 AIPO-D APD 20.64 UiO-6, Calcined OSI 20.66 GUS-1 GON 20.67 AIPO-D APD 20.68 Gismondine GIS	19.82	Goosecreekite	GOO
20.08 CIT-5 CFI 20.09 VPI-8 VET 20.18 Di-n-propylamine SAPO-31 ATO 20.34 Gottardite NES 20.35 Diethylamine Theta-1 (Silica ZSM-22) TON 20.45 Chabazite CHA 20.53 EU-1, Calcined, Rehydrated EUO 20.54 Tridymite - 20.55 Tridymite - 20.61 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 Methylbutylamine SAPO-47 CHA 20.64 UiO-6, Calcined OSI 20.65 GUS-1 GON 20.62 Gismondine GIS	20.01	Moganite	~
20.09VP1-8VET20.18Di-n-propylamine SAPO-31ATO20.34GottardiiteNES20.35Diethylamine Theta-1 (Silica ZSM-22)TON20.45ChabaziteCHA20.52Tridymite-20.53EU-1, Calcined, RehydratedEUO20.58Tridymite-20.61Quinuclidine AIPO-22AWW20.622-aminopentane NonasilNON20.62AIPO-DAPD20.64UiO-6, CalcinedOSI20.65GUS-1GON20.66GUS-1GON20.82GismondineGIS	20.08	CIT-5	CFI
20.18 Di-n-propylamine SAPO-31 ATO 20.34 Gottardiite NES 20.35 Diethylamine Theta-1 (Silica ZSM-22) TON 20.45 Chabazite CHA 20.52 Tridymite - 20.53 EU-1, Calcined, Rehydrated EUO 20.58 Tridymite - 20.61 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 AiPO-D APD 20.64 UiO-6, Calcined OSI 20.65 GUS-1 GON 20.61 QuiS-1 GON 20.62 Gismondine GIS	20.09	VPI-8	VET
20.34 Gottardinte NES 20.36 Diethylamine Theta-1 (Silica ZSM-22) TON 20.45 Chabazite CHA 20.52 Tridymite - 20.53 EU-1, Calcined, Rehydrated EUO 20.58 Tridymite - 20.61 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 AIPO-D APD 20.64 UiO-6, Calcined OSI 20.66 GUS-1 GON 20.71 AIPO-D APD 20.82 Gismondine GIS	20.18	Di-n-propylamine SAPO-31	ATO
20.36 Diethylamine Theta-1 (Sifica ZSM-22) TON 20.45 Chabazite CHA 20.52 Tridymite - 20.53 EU-1, Calcined, Rehydrated EUO 20.58 Tridymite - 20.61 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 AiPO-D APD 20.64 UiO-6, Calcined OSI 20.66 GUS-1 GON 20.67 AIPO-D APD 20.68 Gismondine GIS	20.34	Gottardite	NES
20.45 Chabazite CHA 20.52 Tridymite - 20.53 EU-1, Calcined, Rehydrated EUO 20.58 Tridymite - 20.61 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 AIPO-D APD 20.62 Methylbutylamine SAPO-47 CHA 20.66 GUS-1 GON 20.67 AIPO-D APD 20.68 Gismondine GIS	20.36	Diethylamine Theta-1 (Silica ZSM-22)	TON
20.52 Tridymite - 20.53 EU-1, Calcined, Rehydrated EUO 20.58 Tridymite - 20.61 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 AIPO-D APD 20.62 Methylbutylamine SAPO-47 CHA 20.64 UiO-6, Calcined OSI 20.66 GUS-1 GON 20.71 AIPO-D APD 20.82 Gismondine GIS	20.45	Chabazite	CHA
20.53 EU-1, Calcined, Rehydrated EUO 20.58 Tridymite - 20.61 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 AIPO-D APD 20.62 Methylbutylamine SAPO-47 CHA 20.64 UiO-6, Calcined OSI 20.66 GUS-1 GON 20.71 AIPO-D APD 20.82 Gismondine GIS	20.52	Tridymite	
20.58 Tridymite - 20.61 Quinuclidine AIPO-22 AWW 20.62 2-aminopentane Nonasil NON 20.62 AIPO-D APD 20.62 Methylbutylamine SAPO-47 CHA 20.64 UiO-6, Calcined OSI 20.66 GUS-1 GON 20.71 AIPO-D APD 20.82 Gismondine GIS	20.53	EU-1, Calcined, Rehydrated	EUO
20.61Quinuclidine AIPO-22AWW20.622-aminopentane NonasilNON20.62AIPO-DAPD20.63Methylbutylamine SAPO-47CHA20.64UiO-6, CalcinedOSI20.66GUS-1GON20.71AIPO-DAPD20.82GismondineGIS	20.58	Tridymite	-
20.62 2-aminopentane Nonasil NON 20.62 AIPO-D APD 20.62 Methylbutylamine SAPO-47 CHA 20.64 UiO-6, Calcined OSI 20.66 GUS-1 GON 20.71 AIPO-D APD 20.82 Gismondine GIS	20.61	Quinuclidine AIPO-22	AWW
20.62AIPO-DAPD20.62Methylbutylamine SAPO-47CHA20.64UiO-6, CalcinedOSI20.66GUS-1GON20.71AIPO-DAPD20.82GismondineGIS	20.62	2-aminopentane Nonasil	NON
20.62Methylbutylamine SAPO-47CHA20.64UiO-6, CalcinedOSI20.66GUS-1GON20.71AIPO-DAPD20.82GismondineGIS	20.62	AIPO-D	APD
20.64 UiO-6, Calcined OSI 20.66 GUS-1 GON 20.71 AIPO-D APD 20.82 Gismondine GIS	20.62	Methylbutylamine SAPO-47	CHA
20.66 GUS-1 GON 20.71 AIPO-D APD 20.82 Gismondine GIS	20.64	UiO-6, Calcined	OSI
20.71AIPO-DAPD20.82GismondineGIS	20.66	GUS-1	GON
20.82 Gismondine GIS	20.71	AIPO-D	APD
	20.82	Gismondine	GIS

2 <i>0</i> °	Material	Code
20.86	Alpha Quartz	-
20.96	UTD-1	DON
20.97	Tetrapropylammonium Fluoride AlPO-5	AFI
21.03	Amicite	GIS
21.04	Di-isopropylamine MnAPO-11	AEL
21.10	Barium Chloroaluminosilicate	MER
21.13	AIPO-25	ATV
21.18	Cobalt Gallophosphate	LAU
21.22	Bikitaite	BIK
21.23	AlPO-11, Calcined	AEL
21.52	Di-n-propylamine MAPO-43	GIS
21.52	STA-2	SAT
21.57	Gobbinsite	GIS
21.60	Cs-Aluminosilicate	CAS
21.67	Na-P1	GIS
21.68	Tridymite	
21.87	AIPO - H2	AHT
21.89	Stilbite	STI
21.90	Stellente	STI
21.92	Barrerite	511
22.00	Alpha Cristobalite	
22.03	I-aminoadamantane IVU-3	LEV
22.03	Quinuclidine AIPO-16 Quinuclidinium fluoride este desseil	ASI
22.13	Quinucilumini iluoride occadecasti Houlondito	NEI
22.22	Tetreprepular menium Elueride AIBO 5	AFI
22.30	Clinentilelite	MEII
22.49	Parlialita	LTL.
22.52	Di-n-propylamine SAPO_31	ATO
22.00	MAPO-30	ATN
22 60	VPL5	VFI
22.62	Ouinuclidinium fluoride octadecasil	AST
22.65	ASU-7	ASV
22.96	Epistilbite	EPI
23.05	Boggsite	BOG
23.11	Cobalt Gallium Phosphate-5	CGF
23.13	ZSM-11, Calcined	MEL
23.24	Magnesium Phosphate UiO-20	DFT
23.48	ASU-7	ASV
23.53	Offretite	OFF
23.57	(Na, Tetramethylammonium)-E	EAB
23.78	Rho, Deuterated Berylloarsenate	RHO
23.86	Keatite	-
23.86	Franzinite	FRA
23.95	Liottite	LIO
23.96	AIPO-EN3	AEN
24.08	Afghanite	AFG
24.16	Pahasapaite	RHO
24.18	Di-n-propylamine CoAPO 50	AFY
24.65	Sodalite Octahydrate	SOD
24.68	Cs-Aluminosilicate	CAS
24.71	Bicchulite	SOD
24.79	Edingtonite	EDI
24.79	Meianophiogite	MEP
24.80	rugtupite	500
24.83	Us-Aluminosilicate	CAS
25.14	1ugtupite	30D 200
20.14	Ano, nyaratea	
20.10 95.10	Laumonine Cobalt Callophospheta	LAU
25.19	Cooait Ganophosphate	LAU

20°	Material	Code
25.37	Leonhardite	LAU
25.42	Thomsonite	THO
25.59	MCM-35	MTF
25.73	Dachiardite	DAC
25.76	Bikitaite	BIK
25.77	Wenkite	-WEN
25.96	Analcime	ANA
26.03	Keatite	-
26.07	Magnesium Phosphate UiO-20	DFT
26.10	Nepheline Hydrate	JBW
26.29	Moganite	-
26.49	Tiptopite	CAN
26.65	Alpha Quartz	-
26.73	Moganite	-
26.73	Keatite	-
26.91	Liottite	LIO
27.01	Montesommaite	MON
27.02	Afghanite	AFG
27.02	Rho, Deuterated Berylloarsenate	RHO
27.43	VPI-7	vsv
27.46	Pahasapaite	RHO
27.54	Tetramethylammonium OH AlPO-12	ATT
27.66	Di-n-propylamine MAPO-43	GIS
27.72	ACP-1	ACO
27.74	Cancrinite	CAN
27.89	Phillipsite	PHI
28.10	Na-P1	GIS

20°	Material	Code
28.15	Li-ABW	ABW
28.33	Garronite	GIS
28.37	Wenkite	-WEN
28.42	Montesommaite	MON
29.03	AIPO – H2	AHT
29.10	VPI-9	VNI
29.29	Yugawaralite	YUG
29.36	OSB-1	OSO
29.50	Li-ABW	ABW
30.19	Tiptopite	CAN
30.40	Chabazite	CHA
30.50	Brewsterite	BRE
30.54	Analcime	ANA
30.96	Scolecite	NAT
30.98	Mesolite	NAT
31.01	Gonnardite	NAT
31.22	Natrolite	NAT
31.44	Alpha Cristobalite	-
31.99	Sodalite Octahydrate	SOD
32.07	Bicchulite	SOD
32.08	Beryllophosphate-H	BPH
32.32	Barium Chloroaluminosilicate	MER
35.58	Tiptopite	CAN
35.73	Weinebeneite	WEI
36.15	Alpha Cristobalite	-
39.49	Alpha Quartz	
43.51	Bicchulite	SOD